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Proximate, Color and Amino Acid Profile of Indonesian Traditional Smoked Catfish

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Abstract: Commercial smoked fish from two species of Catfish (*Macrones nemurus* and *Cryptopterus micronema*) were purchased from local markets and analyzed for their proximate composition, color and amino acid profile. Proximate analysis showed that there were significant differences ($p<0.05$) among the samples. Smoked *Macrones nemurus* showed higher fat contents and lower protein contents compared to smoked *Cryptopterus micronema*. The protein and fat contents of *Macrones nemurus* were 32.25 and 32.06%, respectively and they were 38.81 and 8.02%, respectively for *Cryptopterus micronema*. Color analysis showed that there were no significant differences among the samples. The color range of L (lightness), a (redness) and b (yellowness) values of the samples were 40.12-41.59, 5.84-6.28 and 20.79-21.74, respectively. The samples showed the presence of essential amino acids. Smoked *Cryptopterus micronema* fish showed a higher chemical score, amino acid score and essential amino acid index compared to smoked *Macrones nemurus* fish. The chemical score, amino acid score and essential amino acid index for smoked *Cryptopterus micronema* fish were 70.81, 100.00 and 83.18, respectively and were 69.57, 85.69 and 77.62 for *Macrones nemurus*. Generally, these results showed that the quality characteristics of smoked fish are influenced by the fish species, smoking process or other factor. However the smoking process did not cause a reduction in protein quality.

Key words: Smoked fish, catfish, proximate composition, amino acid composition, protein quality

INTRODUCTION

Fish is a food that is very often processed by different methods. Among the processed fish, smoked and dried fish are traditional products which play important roles in the diet of a large section of the world's population (Olley *et al*., 1989). Yanar (2007) reported that the acceptance of smoked fish in developed countries is based primarily on the sensory characteristics it imparts to the product. In Europe about 15% of the total quantity of fish for human consumption is smoked prior to release to the market (Stolyhwo and Sikorski, 2005). The smoking process was basically used in the past for preservative purposes, although the changes in color, odor, flavor and texture, which were produced in foods by this process, were also seen as desirable. The process of smoking combines the effects of salting, drying,

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heating and smoking. The first step, salting, usually involves soaking in a prepared salt solution to firm the flesh and impart flavour. Subsequent drying often performed outdoors or occasionally in a smokehouse, removes excess water from the flesh. A combined heating/drying/smoking process entails application of smoke, at temperatures of 30°C for a cold smoked product or alternatively 70 to 80°C for a hot smoked product (Bligh *et al*., 1989).

The purpose of cold smoking is to steadily decrease the humidity as the temperature increases, making the product more delicate and preserving the meat. Sigurgisladottir *et al.* (2000) reported higher yield obtained for the samples smoked at 30°C as compared to 20°C. A possible explanation could be that the high temperature made a film on the top of the fillets preventing fat leakage and/or evaporation. However, lower smoked temperature (16°C) was able to produce lower scores for odour global intensity and ash note compared to those samples smoked at 24 or 32°C.

Hot smoking is a pasteurizing process, the preservative effect of which depends on the composition and preparation of raw materials, temperature, relative humidity, density and the composition of the smoke as well as the smoking time (Kolodziejska *et al*., 2002). In hot-smoking, the process may be carried out in different stages, during which the temperature of the smoke ranges from about 40-100°C and that the centre of the product may reach up to 85°C (Stolyhwo and Sikorski, 2005).

Today the smoking process is a traditional method of considerable economic importance worldwide. For this reason, the smoking technique has prompted interest among researchers to obtain high value-added food products from undervalued fish species. Mackerel, sprat, herring, salmon and trout are used as raw materials for smoked fish in Poland (Kolodziejska *et al*., 2002; Usydus *et al*., 2009). Smoked salmon is highly valued in France (Espe *et al*., 2004). Fresh water fishes such as tilapia was also found to be suitable to used as raw material for the production of smoked fish (Asiedu *et al*., 1991; Yanar *et al*., 2006). Catfish *Clarias gariepinus* is relatively cheap and is used as raw material for smoked fish in Turkey and Nigeria (Yanar, 2007; Adebowale *et al*., 2008). Catfish *Wallago attu* is used as raw material for smoked fish in India (Lilabati and Vishwanath, 1996). Catfish *Pangasius sutchi* is used as raw material for smoked fish in Indonesia (Amin and Tjipto, 2001). Other catfishes that are used as a raw material in Indonesia are *Macrones nemurus* and *Cryptopterus*. The objectives of the present study was to analyze the nutritive and sensory qualities of two traditionally smoked catfish available in Indonesia, namely Baung (*Macrones nemurus*) and Lais (*Cryptopterus micronema*).

MATERIALS AND METHODS

Smoked Catfish Samples

Commercial smoked catfish from two different species, namely Baung (*Macrones nemurus*) and Lais (*Cryptopterus micronema*), were procured in March 2008 in the local traditional market in Kampar Regency, Riau Province, Indonesia. The samples were brought to the laboratory of the Food Technology Division, Universiti Sains Malaysia, Malaysia to determine the proximate and amino acid composition and color of the fish. Usually the common process for traditional fish smoking starts with gutting and washing the fish with water. The fish were then immersed in vinegar solutions and later, in salt solutions (5-18% of the total fish flesh) for 15-30 min or until the flesh turns pale or white in color. The flesh was then placed in a traditional smoking kiln taking care to avoid cross contamination; then, the flesh was smoked (hot smoking) for 8 to 12 h.

Proximate Composition

The proximate composition of collected fish samples was determined according to the AOAC (1990) methods. The moisture content was determined by drying samples overnight at 105°C until constant weight was achieved (Memmert UL 40, Germany). Crude protein content was determined using the Kjeldahl method (Kjeltec System 1002, Sweden). Crude fat content was determined as per using the Soxhlet method and the ash content was by ashing the samples overnight at 550°C (Thermolyne Sybranm model: 6000, USA). Carbohydrate content was calculated by difference; i.e., the sum total percentage of moisture, crude protein, crude fat and ash content were subtracted from 100%).

Color Measurement

The color of the smoked catfish samples was measured using a colorimeter (Minolta spectrophotometer CM 3500d, Japan). The color readings taken were lightness (L), (a) redness and (b) yellowness. The equipment was standardized with a white tile. Five measurements were taken for each L, a and b values.

Amino Acid Composition

The amino acid composition of the samples was analyzed by digesting the samples for 24 h at 110°C in an oven with 5 mL of 6 N HCl in sealed glass tubes. An aliquot of the hydrolysate was taken and 0.4 mL AABA (alpha amino butyric acid (50 μmol mL^{-1})) was added to it as the internal standard. Then 100 mL of distilled water was added to the aliquot. This aliquot was then filtered using Whatman filter paper followed by a syringe filter. Sulfur amino acid, methionine and cystine were oxidized with 2 mL performic acid prior to hydrolysis with 6 N HCl. The tryptophan content was not determined. All samples were derivatized with an AQC reagent and borate buffer before being separated using High Performance Liquid Chromatography (HPLC) using eluent A (AccQ Taq TM concentrate, Waters) and eluent B (Acetonitrile 60%, Sigma). The HPLC with the Waters brand system consisted of the following items: a multi-fluorescence detector Waters 2475 (excitation at 250 nm and emission at 395 nm), a Waters 717 auto-sampler and a Waters binary 1525 HPLC pump and bus satin model. The column size was 3.9×150 mm. The eluent flowed at a rate of 1 mL min^{-1}. A standard calibration mixture was prepared from a commercial amino acid mixture (Standard H, Pierce Chemical, Rockford) and from the individual amino acid (Sigma).

The chemical scores calculated from the essential amino acid concentrations of samples were compared with the essential amino acid pattern for whole eggs, whereas amino acid scores were calculated by using the 1985 FAO/WHO/UNU (FAO/WHO, 1990) suggested pattern of amino acid requirements for preschool children (2-5 years old). Chemical scores or amino acid scores actually is the ratio of a gram of the essential amino acid in a test sample to the same amount of the corresponding amino acid in a reference (e.g., whole-egg protein or FAO/WHO/UNU suggested pattern) multiplied by 100. The Essential Amino Acid Index (EAAI) was determined by calculating the log10 of the chemical score. The mean was calculated and the antilog was taken as the EAAI (Acton and Rudd, 1986).

Statistical Analysis

A t-test was used to evaluate the data and significant differences among means were determined by independent sample t-tests.

RESULTS

Table 1 shows the proximate composition and color of smoked catfish from two species. There was a significant difference in their proximate compositions. The percentage of moisture, total protein, ash and carbohydrate in the smoked catfish *Macrones nemurus* was lower than that of *Cryptopterus micronema*; however, the fat content of *Macrones nemurus* was higher. Baung catfish *Macrones nemurus* is known as kind a fatty fish with round shape of body and Lais catfish *Cryptopterus micronema* is known as kind of lean fish with thin body shape. There were no statistical differences in the color properties of the samples. The color of smoked catfish from the *Macrones nemurus* slightly lighter compare than smoked catfish from the *Cryptopterus micronema*. Color is the important attribute to the quality of smoked fish and usually the manufacturer will complete smoking process after the products reach the certain characteristics of color.

The amino acid compositions of two different species of smoked catfish shown in Table 2 indicate that the essential amino acid content is generally higher in smoked *Cryptopterus micronema* than in smoked *Macrones nemurus*. The glutamic acid content is higher than the other amino acids. The chemical score, acid amino score and essential amino acid index of smoked *Macrones nemurus* and *Cryptopterus micronema* are also shown in Table 2. The chemical score, amino acid score and essential amino acid index for smoked *Cryptopterus micronema* fish were 70.81, 100.00 and 83.18, respectively and were 69.57, 85.69 and 77.62 for *Macrones nemurus*.

Table 1: Proximate composition (% wb) and color of Indonesian smoked catfish

Parameters	*Macrones nemurus*	*Cryptopterus micronema*
Moisture (%)	15.35±0.48a	19.91±0.18b
Protein (%)	32.25±0.44a	38.81±0.68b
Fat (%)	32.06±0.07a	8.02±0.14b
Ash (%)	5.41±0.47a	0.73±0.58b
Carbohydrate (%)	14.92±1.21a	26.53±0.57b
Lightness (L)	41.59±7.46a	40.12±7.35a
Redness (a)	5.84±2.01a	6.28±1.19a
Yellowness (b)	20.79±4.18a	21.74±5.68a

Data are Mean±SD. Means with the same letter(s) within the same column are not significantly different ($p<0.05$)

Table 2: Amino acid composition (mg 100 g^{-1}) and protein quality of Indonesia smoked catfish

Amino acid	*Macrones nemurus*	*Cryptopterus micronema*
Aspartic acid	4.98	5.86
Glutamic acid	8.11	9.18
Serine	3.79	4.21
Glycine	2.11	4.55
Histidine	3.34	3.03
Arginine	6.93	8.01
Threonine	5.46	5.81
Alanine	3.51	4.10
Proline	2.83	2.81
Tyrosine	2.41	2.44
Valine	5.89	6.34
Methionine	2.97	2.26
Cysteine	1.28	1.84
Isoleucine	4.46	4.63
Leucine	6.34	6.92
Phenylalanine	4.47	5.19
Lysine	4.97	5.80
Chemical score	69.57	70.81
Amino acid score	85.69	100.00
Essential amino acid index	77.62	83.18

DISCUSSION

The moisture content of Indonesian smoked catfish is lower compared to the moisture content of Thailand smoked fish or pla krob and Japanese cold smoked fish. Kiatkungwalkrai (1992) reported that the moisture content of Thailand catfish, which was smoked for 2 h at 80°C, was 65.54% and for 3 h at 80°C, was 65.48%. Previously, Motohiro (1989) reported the proximate composition of Japanese herring cold smoked fish, which was smoked at 30°C for 15 days contained 36.50% moisture, 37.43% protein, 14.50% fat and 15.43% ash. Commercial smoked fish products in Poland showed the moisture, protein, fat and ash content ranged between 57.6-68.2, 19.5-23.3, 6.06-20.8 and 2.2-4.56%, respectively (Usydus *et al*., 2009). The moisture content of Indonesian smoked catfish is higher compared to the moisture content of Nigerian smoked catfish. Adebowale *et al.* (2008) reported that the range of moisture, protein, fat and ash content of Nigerian smoked catfish were 7.16-10.71, 33.660-66.04, 1.58-6.09 and 9.12-12.16%, respectively. These means the proximate compositions of smoked fish products will different according to the producer country. The variations of the proximate compositions of smoked fish were caused by different factors, such as fish species, smoking methods (hot or cold), smoking time, salting method (dry or wet) and salt concentration. Furthermore, variations in the proximate composition of the smoked fish and the conditions of processing will affect the sensory quality, shelf life and wholesomeness of the product.

The color of Indonesian smoked catfish are closely similar to the color of smoked Atlantic salmon as reported by Rora *et al.* (1998). The L, a and b values for smoked Atlantic salmon were reported to be 41.0±2.12, 9.5±1.07 and 8.4±1.84. Similar results were also reported in cold-smoked salmon collected in French hypermarket (Espe *et al*., 2004). The L, a and b values of cold-smoked salmon provenance from Norwegian, Scottish and Irish were in the range of 43.9-57.5, 9.3-17.2 and 8.1-22.5, respectively. Luten *et al.* (1979) stated that during the smoking process the lignins of the wood, consisting of quaiacylpropane and syringyl-propane, are pyrolyzed, giving a complex mixture of phenolic compounds, polycyclic aromatic hydrocarbons and carbonyl compounds. It is assumed that reactions among the carbonyl compounds and the proteins are mainly responsible for the color formation on the smoked surface, while the absorbed phenolic compounds are closely related to the flavor and aroma of the smoked product. However, the lighter smoked fish product can be produced by smoking the fish using an electrical steamer at pressures of up to one bar (Luten *et al*., 1979). Siskos *et al.* (2005) reported that the color of liquid-smoked trout smoking at two bars of pressure were 69.1 in L value, 3.8 in a value and 16.2 in b value. These means if the market looking for lighter color of smoked fish, the producer can use this method to produce lighter color of smoked fish.

Studies on the effects of cooking, frying and smoking on the amino acid compositions of three types of fish (*Sardinella* sp., *Dantex* sp. and *Tilapia* sp.) have been carried out by Asiedu *et al.* (1991). The results indicate that these processing methods had no effect on the amino acid composition compared with fresh fish. All the processed fish had good quality protein as expressed by their high digestibility and protein utilization. More recent studies by Usydus *et al.* (2009) showed smoked fish products could serve as a significant source of essential amino acids. The contents of lysine and sum of essential amino acids in smoked fish products were significantly higher in comparison with salted and marinated fish products. Acton and Rudd (1986) reported that the chemical score and essential amino acid index of various classifications of seafood's was generally around 57-75 (average 67) and

79-90 (average 85), respectively. This result shows that the protein quality of the Indonesian smoked catfish samples with a chemical score range of 69.57-70.81 and essential amino acid index range of 77.62-83.18 were the range of good sources of protein.

CONCLUSION

The smoking process brings about changes in quality parameters such as proximate and amino acid composition and color. The results showed that the two traditional Indonesian smoked Catfish posses good protein quality. The protein contents of *Macrones nemurus* and *Cryptopterus micronema* were 32.25 and 38.81%, respectively. The chemical score, amino acid score and essential amino acid index for smoked *Cryptopterus micronema* fish were 70.81, 100.00 and 83.18 and for *Macrones nemurus* were 69.57, 85.69 and 77.62, respectively.

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